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09/821,753	03/30/2001	Tuqiang Ni	2328-053	5171

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EXAMINER	
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1763	

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see enclosed examiner's answer

Luz L. Alejandro
Primary Examiner
Art Unit: 1763

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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 09/821,753
Filing Date: March 30, 2001
Appellant(s): NI ET AL.

Allan M. Lowe
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 4/6/05.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is substantially correct with the exception that claims 1-6, **8-13**, 14, 16-18, 20-28, and 30-31 are pending claims.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is substantially correct. The instant claimed invention is directed to a method of etching a workpiece in a vacuum plasma processor chamber comprising converting a gas species into an AC etchant plasma that is continuously applied to the workpiece while a feature of the

workpiece is being formed, the vacuum chamber being subject to operating at different pressures while the workpiece is being processed, the gas species being subject to flowing into the chamber at different flow rates while the workpiece is being processed, gradually changing, on a pre-programmed basis, the amount of AC power supplied to the plasma during etching of the workpiece, wherein a gradual transition in the shape of material in the workpiece being processed occurs in response to the gradual power change, the gradual power change occurring during the gradual transition in the shape of the material, as claimed in independent claim 1.

Also, the instant claimed invention is directed to a computer program for controlling a computer for controlling etching of a workpiece in a vacuum plasma processor chamber wherein a gas species is converted into an AC etchant plasma, the chamber being capable of operating at different pressures while the workpiece is being processed, the gas species being subject to flowing into the chamber at different flow rates while the workpiece is being processed, the computer program storing signals causing (a) control of the amount of AC power applied to the plasma while the workpiece is being etched; and (b) the continuous application of the AC etchant plasma to the workpiece while a feature of the workpiece is being formed, the stored signal for controlling the amount of AC power causing gradual preprogrammed changes in the amount of AC power supplied to the etchant plasma during etching of the workpiece, the stored signal causing gradual power change being such as to cause a gradual transition in the shape of material in the workpiece being etched in response to the

gradual power change to cause the gradual power change to occur during the gradual transition in the shape of the material, as claimed in independent claim 17.

Furthermore, the instant claimed invention is directed to the method of and the computer program, wherein the gradual power change occurs while no change is made in (a) the species, (b) the pressure or (c) the flow rate, as claimed in claims 2 and 18, respectively.

Additionally, the instant claimed invention is directed to the method, wherein the species is ionized into a plasma that etches the material to form the feature, the gradual power change, the species and the continuous application of the plasma to the workpiece being such that the material is shaped to have a rounded corner that includes the formed feature in response to changes in the ionized plasma etchant resulting from the gradual power change, as claimed in claim 8.

The method of claim 9 is directed to the method of etching of claim 8, wherein the etching, which occurs in response to changes in the ionized plasma etchant resulting from the gradual power change and the continuous application of the plasma to the workpiece, forms a trench wall including the rounded corner, the trench and the rounded corner being included in the formed features. Claim 10 is directed to the method of etching of claim 9, wherein the rounded corner is at an intersection of a wall and a base of a trench. The method of claim 11 is directed to the method of etching of claim 8, wherein the rounded corner is at an intersection of a wall and a surface intersecting the wall, the surface extending generally at right angles to the wall. The

method of claim 12 is directed to the method of etching of claim 1, wherein the power steps are a few milliwatts and remain at a constant power for about 1 millisecond.

Claim 20 is directed to the memory of claim 17, wherein the stored signals control etchant species supplied to the chamber while the workpiece is being processed and the gradual power transition so as to cause the workpiece to be etched to have a rounded corner. And, claim 21, is directed to the memory of claim 20, wherein the stored signals control etchant species supplied to the chamber while the workpiece is being processed and the gradual power transition so as to cause the workpiece to be etched to have a trench wall including the rounded corner.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

The following is a listing of the evidence (e.g., patents, publications, Official Notice, and admitted prior art) relied upon in the rejection of claims under appeal.

Bhardwaj et al.	6,051,503	04-2000
Howald et al.	WO 00/58992	10-2000

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1-6, 8-13, 17-18, 20-23, 25-26, 28, and 30-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bhardwaj et al., U.S. Patent 6,051,503 in view of Howald et al., WO 00/58992.

Bhardwaj et al. shows the process substantially as claimed including a method of etching a workpiece in a vacuum plasma processor chamber comprising converting a gas species into an AC etchant plasma that is continuously applied to the workpiece

while a feature of the workpiece (for example, a portion of the sidewall of the trench) is being formed, the vacuum chamber being subject to operating at different pressures while the workpiece is being processed (see abstract), the gas species being subject to flowing into the chamber at different flow rates while the workpiece is being processed (also see abstract), gradually changing, the amount of AC power supplied to the plasma during etching of the workpiece (see col. 6-lines 43-47 and abstract), wherein a gradual transition in the shape of material in the workpiece being processed occurs in response to the gradual power change, the gradual power change occurring during the gradual transition in the shape of the material (see abstract, col. 6-lines 43-49, col. 8-line 57 to col. 9-line 26, and figs. 19A-19B). Note that inherently a gradual power change will also produce a rounded profile in Bhardwaj et al. since the gradual power change in the instant application similiarly produces a rounded profile.

Bhardwaj et al. fails to expressly disclose: wherein the gradual change is pre-programmed, and wherein the electrode is responsive to an AC power source that is supplied by a coil coupling an RF plasma excitation field to the chamber. Howald et al. discloses a method of processing by etching (see page 1-lines 15-19) a workpiece in a vacuum plasma processor chamber including computers 20 and 34 and wherein a gas species is converted into an AC plasma (see page 6-lines 17-20). Note also that the AC power is supplied by an electrode 56 being on a holder for the workpiece and the electrode is responsive to an AC power source that is supplied by a coil 48 coupling an RF plasma excitation field to the chamber. In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify

the process of Bhardwaj et al. so as to include a process using the apparatus of Howald et al. because such an apparatus allows for a high level of control over the plasma process being performed. Moreover, with respect to the changes in power being pre-programmed, it would have been obvious to one of ordinary skill in the art at the time the invention was made to pre-program the power change into the microprocessors 20,34 of Howald et al. because in such a way operator error will be eliminated. Moreover, merely using a computer to automate a known process does not by itself impart nonobviousness to the invention. See Dann v. Johnston, 425 U.S. 219, 227-30, 189 USPQ 257, 261 (1976); In re Venner, 262 F.2d 91, 95, 120 USPQ 193, 194 (CCPA 1958).

With respect to claims 2 and 18, note that the process can be conducted while no change is made in the species, the pressure, or the flow rate since the abstract of Bhardwaj et al. states only one or more of the parameters need to be changed.

Concerning claims 8-11 and 21-22, note that in Bhardwaj et al. the species is ionized into a plasma that etches the material to form the feature, the gradual power change (see abstract and col. 6-lines 43-49) , the species, and the continuous application of the plasma to the workpiece being such that the material is shaped to have a rounded corner that includes the formed feature, which includes a trench wall having a lower rounded corner, in response to changes in the plasma etchant resulting from the gradual power change (note that by gradually changing the power the corner of the trench will be rounded similarly as in the instant application).

With respect to claims 12-13, 26, 28, and 30-31, concerning the specific time period to which the power remains at constant wattage and the amount the power is changed, it would have been obvious to one of ordinary skill in the art at the time the invention was made to determine through routine experimentation the optimum amount of time at which the power should remain constant and the optimum amount the power is changed, to achieve the desired rounded profile of the trench and such limitations would not lend patentability to the instant application absent a showing of unexpected results.

(10) Response to Argument

Appellant's arguments filed 4/6/05 have been fully considered but are not persuasive. Appellant argues that the ramping of the parameters such as the power were performed in Bhardwaj et al. for a different reason than in the instant application. In response to applicant's argument that the parameters are ramped in the Bhardwaj et al. reference for a different reason than in the instant application, the fact that applicant has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985). Furthermore, appellant argues that the process of Bhardwaj et al. conducts deposition and etching and the features such as the rounded trench corners shown in fig. 11 are formed by both processes rather than solely etching. However, note that the claim uses the transitional phrase "comprising" and therefore if both

etching and deposition are conducted simultaneously, the references read on the claims (see figs. 19A-19B which shows this feature). Moreover, in response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., rounding the trench corners solely by etching) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993). Furthermore, Bhardwaj et al. clearly describes with respect to the prior art of figs. 1-2, that the deposition process forms a passivation layer 21 and the etching process forms the trench sidewalls (see col. 4-lines 3-8), which clearly indicates that the trench itself is formed solely by etching. Therefore, one would expect that the rounded corners of the trench shown in fig. 11 to also be formed solely by etching. Additionally, the rounded trench corners of the instant application are formed by a gradual power change and, absent evidence to the contrary, it is unclear why the same gradual power change in Bhardwaj et al. would also not produce the rounded trench corners. Moreover, appellant continually mentions the deposition and etching process steps in Bhardwaj et al. as if they are discrete and independent steps. However, Bhardwaj et al. clearly states that the deposition and etching steps can overlap (see col. 1-lines 49-50) and therefore this analysis is improper.

Appellant further argues that there is no discussion in Bhardwaj et al. of forming a feature as a result of the continuous application of etchant. First, the word "feature" can be interpreted to be, for example, one portion of the trench (no matter how small)

and does not require that the etchant be continuously applied for the entire trench formation. Second, the deposition and etching gases can be ninety degrees out of phase with each other so that the processes are conducted simultaneously and therefore the etching gases can be present in either a large or small amount which is inversely related to the deposition gases (see col. 7-lines 14-31). In either case, the claimed limitation has been met. Moreover, appellant argues that it is improper to consider, for example, the jagged sidewalls of Bhardwaj et al. as a feature of the invention since it is undesirable. However, Bhardwaj et al. discloses ways in which to eliminate the jagged sidewalls, for example, by gradually changing the power as is done in Bhardwaj et al. and the instant application. Furthermore, there is nothing in the definition of the word "feature" that says a specific "feature" needs to be either desirable or undesirable. Regarding the argument that the examiner is wrong in saying Bhardwaj et al. discloses continually applying AC etchant plasma to a workpiece while a feature of the workpiece is being etched, the examiner respectfully disagrees since the word "feature" can be interpreted as discussed above and because Bhardwaj et al. discloses processes whereby the etching and deposition steps are conducted together in varying amounts of gas introduction (see, for example, fig. 19A, which shows inversely varying the flow rates of the etching and deposition gases).

Concerning claims 2 and 18, appellant argues that Bhardwaj et al. fails to disclose forming a feature of a trench without changing flow rate and species. However, note from the abstract that there are embodiments in which only one of, for example, gas flow rates, chamber pressure, plasma power, and substrate bias are changed which

clearly indicates that the others are kept constant. Furthermore, the etching species are not changed during the etching process. Moreover, this is during the process of forming a feature which can be considered to be a very small part of the overall process. For at least these reasons, the claimed limitations have been met.

Regarding appellant's argument of claims 8 and 20, the examiner notes that in this portion of the appeal (first full paragraph of page 13), appellant states no rounded corners are shown in fig. 11, while in other portions of the appeal (see page 9, lines 4-8), appellant states that the trench shows rounded portions. Furthermore, it is unclear why in the instant application a gradual change in the power will form a rounded corner whereas in Bhardwaj et al. such a gradual power change will not form a rounded corner. Appellant also argues that while a rounded corner may be shown in fig. 18, there is no teaching that the rounded corner is formed by the continuous application of etchant plasma to the workpiece while a gradual change in the power occurs. However, it is clear that a process such as the one outlined in figs. 19A-19B where the etching and deposition processes are simultaneously conducted but using inversely varied amounts of gas introduction will meet this claim limitation, along with dependent claims 9-11 and 21.

Concerning the argument of claims 12-13, appellant has not provided any secondary evidence, for example, an affidavit or declaration alleging unexpected results, and therefore absent such a showing the rejection under 35 USC 103(a) is proper. The fact that the instant application has steps of shorter duration than the Bhardwaj et al. reference is not relevant particularly when other parameters such as the

power applied will also determine what duration is appropriate for a particular application.

In the concluding arguments, appellant contends that the claims of the instant application differ from Bhardwaj et al. in that the claims require a continuous application of AC etchant plasma to a workpiece while a feature is being formed. However, the examiner respectfully disagrees because: 1) a feature need not represent the entire trench but only needs to represent, for example, a small portion of a sidewall, and 2) a process such as shown in figs. 19a-19b where both deposition and etching are simultaneously performed would read on the feature being the entire trench since etchant plasma is continuously applied during trench formation. Furthermore, by gradually changing the etchant power, the rounded corners would be expected to be produced since this is the same method in which the rounded corners are produced in the instant application.

Concerning claims 2 and 18, and as discussed above, these claims are satisfied by the abstract and the realization that a reference is not limited by specific embodiments, and regarding the length of duration being different in the instant application and the Bhardwaj et al. reference, the durations of time in the reference are preferred and not absolute. Furthermore, the amount of time of each duration is based on other factors, for example, etching at a higher power would require less time to etch the same amount of material as etching at a lower power and therefore the particular length of duration would be determined during routine experimentation depending upon,

for example, the desired power or depth of the trench and would not lend patentability to the instant application absent a showing of unexpected results.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Luz L. Alejandro

Art Unit 1763
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